Patent
Attorney's Docket No. <u>031211-068</u>

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	
Andreas HELD et al.	Group Art Unit: Unassigned
Application No.: Unassigned	Examiner: Unassigned
Filed: January 30, 2002	
For: AUTOMATIC COLOR DEFECT CORRECTION (As Amended)	

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir or Madam:

Prior to examination, kindly amend the above-identified application as follows:

IN THE TITLE:

Please change the title from "Automatic Colour Defect Correction" to --Automatic Color Defect Correction--.

IN THE SPECIFICATION:

Kindly delete the paragraph in its entirety on page 2 beginning at line 22.

Kindly replace the paragraph beginning at page 3, line 4 with the following:

--The following references are referred to in order to incorporate the disclosure of these references with respect to the detection of the location of a face and with respect to

the detection of a location of eyes. All these kinds of image processing can be used in accordance with the present invention. According to one prior art reference, the Hough transform was used for the detection of eye centers. In "Robust Eye Centre Extraction Using the Hough Transform", by David E. Benn et al, Proc. First International Conference AVBPA; pp. 3 - 9; Crans-Montana; 1997, the disclosure of which is hereby incorporated by reference in it entirety, a gradient decomposed Hough transform was used which considerably reduces the need for memory space and processing speed of a processing system for image data.--

Kindly replace the paragraph beginning at page 3, line 14 with the following:

--According to another approach, the flow field characteristics, which are generated by the transitions from the dark iris to the rather sclera, were used to detect eyes in an image. As disclosed in "Detection of Eye Locations in Unconstrained Visual Images", by Ravi Kothari et al, Proc. Int. Conf. on Image Processing, ICIP 96; pp. 519-522; Lausanne, 1996, the disclosure of which is hereby incorporated by reference in its entirety, it was proposed to use these flow field characteristics. This attempt uses a field similar to an optical flow field generated for a motion analysis. Afterwards, a two-dimensional accumulator is used to achieve votes for intersections of prominent local gradients.--

Kindly replace the paragraph beginning at page 3, line 22 with the following:

--According to Alan L. Yuil et al, it was proposed in "Feature Extraction from Faces Using Deformable Templates", International Journal of Computer Vision, 8:2, pp.

99 - 111; 1992, the disclosure of which is hereby incorporated by reference in its entirety, to use a deformable template, which provides a model of a human eye. By minimising the costs of such a kind of fit of the template over a number of energy fields, the best fit was iteratively found.--

Kindly replace the paragraph beginning at page 3, line 28 with the following:

--Another kind of automatic eye detection will be referred to below, which was invented by A. Held and has been filed with the European Patent Office under the title "Automatic Image Pattern Detection". The disclosure of this document is hereby incorporated by reference in its entirety.--

Kindly replace the paragraph beginning at page 4, line 9 with the following:

--One advantageous alternative to pre-processing is a specialised portrait mode, so that any kind of pre-processing to reduce the area of the input image, which has to be directed to a detection operation and an automatic face detection, can be omitted and replaced by said specialised portrait mode. However, since usually snap shots taken by ordinary consumers do not merely consist of portrait photographs, but of a mixture of a variety of different motives, the method of the present invention would be restricted if it were to be used only in connection with such a specialised portrait mode. However, in case of the use of a specialised portrait mode, the method according to the present invention could also be used. According to the present invention, to save processing time, the processing of an image is stopped if the processing of an image has not resulted in the

identification of a basic area to be processed are used for other kinds of image processing and are later exposed on photographic printed paper, recorded on a CD-Rom, transmitted via a data line, the Internet or similar, or are recorded or stored on any kind of image information recording device.--

Kindly add the following paragraph on page 9 after the heading "BRIEF DESCRIPTION OF THE DRAWINGS":

--Other objects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments, when read in conjunction with the accompanying drawings wherein like elements have been represented by like reference numerals.--

Kindly replace the paragraph beginning at page 11, line 15 with the following:

--For the actual detection of faces, any system that fulfils this reasonably well will do. This could be for instance a neural network approach, as proposed by Henry Rowley, "Neural Network-Based Face Detection", PhD Thesis CMU-CS-99-117, Carnegie Mellon University, Pittsburgh 1999, or some wavelet based approach, as proposed by Schneiderman et al., "A Statistical Methd for 3D Object Detection Applied to Faces and Cars", Proc. CVPR 2000, Vol. I, pp. 746 - 752, Hilton Head Island 2000. Of importance at this stage is that the detection of faces happens fully automatic and that the detection rate is reasonably high and the false negative rate that is, faces being detected even though there is no face present, is reasonably low. What reasonable constitutes will depend on the actual

context of the application. The disclosures of the Rowley and the Schneiderman references are hereby incorporated by reference in their entireties.--

Kindly replace the paragraph beginning at page 12, line 19 with the following:

--The basic approach for automatic eye detection is outlined in Fig. 4. As pre-processing step, any processing can be incorporated that will enhance facial features, as for instance, histogram normalisation, local contrast enhancement, or even red-enhancement according to Equation (1.1) for red-eye detection. In general, it is a good idea to normalise the input image, both in size and in lightness at this stage. The actual eye detection stage can be performed according to one of the many approaches that can be found in the literature. For instance, Benn et al propose a very interesting approach for the detection of eye centers based on a gradient decomposed Hough transform. Although Hough transforms might not appear the best choice due to rather large requirements on memory and processing speed, they show that this need can be greatly reduced by using the so-called gradient-decomposed Hough transform. A slightly different approach is taken by Kothari et al, "Detection of Eye Locations in Unconstrained Visual Images, Proc. Int. Conf. on Image Processing,; ICIP96; pp. 519-522; Lausanne; 1996, the disclosure of which is hereby incorporated by reference in its entirety, who analyse the flow field characteristics generated by the dark iris in respect to the light sclera. Another approach was proposed by Yuille et al, "Feature Extraction for Faces using Deformable Templates", International Journal of Computer Vision, 8:2, pp. 99-111, 1992, the disclosure of which is hereby incorporated by reference in its entirety. They suggested to use deformable

templates for eye modes which are then drawn to the exact location by optimising the fit over some combination of energy fields. This is a very interesting approach that will give a lot of information about the detected eyes, however, there is a danger of the optimisation procedure being caught in local minima.--

Kindly add the following paragraph after the paragraph beginning at page 22, line 8 with the following:

--It will be appreciated by those skilled in the art that the present invention can be embodied in other specific forms whithout departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are therefore considered in all respects to be illustrated and not restricted. The scope of the invention is indicated by the appended claims rather than the foregoing description and all changes that come within the meaning and range and equivalence thereof are intended to be embraced therein.--

IN THE CLAIMS:

Please replace claims 1-14 with the following:

1. (Amended) Method for automatically correcting color defective areas in an image, said defective color areas being recorded with a color spectrum deviating from the actual color spectrum of said areas without color defects, comprising the steps of:

a) identifying basic areas in the image on the basis of features which are common for recorded defective areas, said basic areas supporting an increased likelihood of including defective areas;

b) reducing a processing to the basic areas to identify at least one of borderlines and centers of the defective areas;

c) identifying whether the basic areas deemed to be defective are defective; and

d) creating a correction mask to correct a visual appearance of the defective area if a basic area has been identified to be defective.

2. (Amended) Method according to claim 1, wherein a specialized portrait mode can be activated in the case of defective red eye detection.

3. (Amended) Method according to claim 1, wherein if after one of the steps 1 a), 1 b), and 1 c) the processing of an image has not resulted in the identification of an area to be processed further, the processing of an image is stopped and another image can be processed.

4. (Amended) Method according to claim 1, wherein: after a center of a basic area has been identified, an expected defect is emphasized in its intensity to detect whether the basic area is defective, and in the case of a detected color, the following equation is used:

$I_{red} = R\text{-}min(G,B)$,

where R refers to a red color channel, G refers to a green color channel, and B refers to a blue color channel.

5. (Amended) Method according to claims 1, wherein the basic areas are treated by an edge detection processing to achieve borderlines of the basic areas.

6. (Amended) Method according to claim 1, wherein in a case that a red eye defect is to be corrected and a position and a size of an iris have been estimated, a maximum of the red eye defect is determined to be an actual position of the iris of an eye.

7. (Amended) Method according to claim 6, wherein neighboring pixels are analyzed with respect to at least one of the actual position and center of the iris considering several curves of an HSV color space, which curves are achieved by analyzing a variety of real-world photographs with red eye defects to acquire fuzzy membership functions of three color channels to be taken into account, and determining intersections between at least three color channel positions of each of the neighboring pixels and said fuzzy membership functions, and deciding on the basis of the intersection values that a particular neighboring pixel is defective if its intersection values exceed a predetermined threshold, wherein a correction mask is created, if these steps are repeated for all relevant pixels.

8. (Amended) Method according to claim 7, wherein a first arrangement around at least one of an equal position or center of the iris forms a first layer of first neighbouring

pixels, and if the first layer of first neighboring pixels is at least partially identified as belonging to the red-eye defective pixels, other second neighbouring pixels with respect to the first neighbouring pixels are analyzed along a same line as the first neighbouring, pixels to be identified as red-eye defective pixels, and if further red-eye defective pixels have been identified, considering further other neighbouring pixels, wherein the correction mask is caused to grow.

9. (Amended) Method according to claim 8, wherein the analysis of and extension to neighboring pixels is terminated if at least one of no further other neighboring pixels have been identified as red-eye defective and if the borderlines of the defective red eye have been at least one of reached and exceeded.

10. (Amended) Method according to claim 8, wherein pixel data representing the correction mask area directed to at least one smoothing operation.

11. (Amended) Method according to claim 8, wherein the correction mask is applied to the matching area of an uncorrected image to remove the color defect.

12. (Amended) Method according to claim 11, wherein the removal of the color defect is practiced by the following equation:

$I_{red\ new} = R\text{-}m(R\text{-}\min(G,B))$,

where m is an element of the correction mask corresponding to a particular pixel of the uncorrected image.

13. (Amended) Method according to claim 11, wherein, if a particular pixel of the uncorrected image has a considerably large difference between the green channel and the blue channel, the larger channel is adjusted in accordance with the following equation:

$I_{red\ new}$= R-m(R-min(G,B)),

where m is an element of the correction mask corresponding to a particular pixel of the uncorrected image.

14. (Amended) An image processing device for processing image data, comprising:

an image data input section;

an image data processing section;

an image data recording section for recording processed image data, wherein the image data processing section implements a method for automatically correcting color defective areas in an image, said defective color areas being recorded with a color spectrum deviating from the actual color spectrum of said areas without color defects, including the steps of:

a) identifying basic areas in the image on the basis of features which are common for recorded defective areas, said basic areas supporting an increased likelihood of including defective areas;

b) reducing the processing to the basic areas to identify at least one of borderlines and centers of the defective areas;

c) identifying whether the basic areas deemed to be defective are defective; and

d) creating a correction mask to correct a visual appearance of the defective area if a basic area has been identified to be defective.

Please add new claims 15-20 as follows:

--15. Method of claim 1, wherein an identification of basic areas in the image includes the use of at least one of skin detection to identify skin related areas, face detection on the basis of a face pictogram, and eye detection.

16. Method of claim 1, wherein defective areas include red eye defects.

17. Method of claim 4, wherein a detected color defect includes a defective red eye.

18. Method of claim 7, wherein intersections are determined using the following equation: $r = hsv/(max(h,s,v))$.

19. Method of claim 11, wherein the correction mask is a gray-scale correction mask.

20. Method of claim 11, wherein the color defect is a red-eye defect.--

REMARKS

The amendments were made to place the application in a more suitable form prior to examination. Favorable consideration is respectfully requested.

Respectfully submitted,

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Date: January 30, 2002

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Page 3, Paragraph Beginning at Line 4

The following references are referred to in order to incorporate the disclosure of these references with respect to the detection of the location of a face and with respect to the detection of a location of eyes. All these kinds of image processing can be used in accordance with the present invention. According to one prior art reference, the Hough transform was used for the detection of eye centers. In "Robust Eye Centre Extraction Using the Hough Transform", by David E. Benn et al, Proc. First International Conference AVBPA; pp. 3 - 9; Crans-Montana; 1997, the disclosure of which is hereby incorporated by reference in it entirety, a gradient decomposed Hough transform was used which considerably reduces the need for memory space and processing speed of a processing system for image data.

Page 3, Paragraph Beginning at Line 14

According to another approach, the flow field characteristics, which are generated by the transitions from the dark iris to the rather sclera, were used to detect eyes in an image. As disclosed in "Detection of Eye Locations in Unconstrained Visual Images", by Ravi Kothari et al, Proc. Int. Conf. on Image Processing, ICIP 96; pp. 519-522; Lausanne, 1996, the disclosure of which is hereby incorporated by reference in its entirety, it was proposed to use these flow field characteristics. This attempt uses a field similar to an

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optical flow field generated for a motion analysis. Afterwards, a two-dimensional accumulator is used to achieve votes for intersections of prominent local gradients.

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Page 3, Paragraph Beginning at Line 28

Another kind of automatic eye detection will be referred to below, which was invented by A. Held and has been filed with the European Patent Office under the title "Automatic Image Pattern Detection". The disclosure of this document is hereby incorporated by reference in its entirety.

Page 4, Paragraph Beginning at Line 9

One advantageous alternative to [the pre-processing in accordance with feature a) of claim 1 can partially also be replaced by] pre-processing is a specialised portrait mode, so

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that any kind of pre-processing to reduce the area of the input image, which has to be directed to a detection operation and an automatic face detection, can be omitted and replaced by said specialised portrait mode. However, since usually snap shots taken by ordinary consumers do not merely consist of portrait photographs, but of a mixture of a variety of different motives, the method of the present invention would be restricted if it were to be used only in connection with such a specialised portrait mode. However, in case of the use of a specialised portrait mode, the method according to the present invention could also be used. According to the present invention, to save processing time, the processing of an image is stopped[, if after one of the steps a) to c) in claim 1,] if the processing of an image has not resulted in the identification of a basic area to be processed are used for other kinds of image processing and are later exposed on photographic printed paper, recorded on a CD-Rom, transmitted via a data line, the Internet or similar, or are recorded or stored on any kind of image information recording device.

Page 9, after heading "BRIEF DESCRIPTION OF THE DRAWINGS"

Other objects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments, when read in conjunction with the accompanying drawings wherein like elements have been represented by like reference numerals.

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Page 11, Paragraph Beginning at Line 15

For the actual detection of faces, any system that fulfils this reasonably well will do. This could be for instance a neural network approach, as proposed by Henry Rowley, "Neural Network-Based Face Detection", PhD Thesis CMU-CS-99-117, Carnegie Mellon University, Pittsburgh 1999, or some wavelet based approach, as proposed by Schneiderman et al., "A Statistical Methd for 3D Object Detection Applied to Faces and Cars", Proc. CVPR 2000, Vol. I, pp. 746 - 752, Hilton Head Island 2000. Of importance at this stage is that the detection of faces happens fully automatic and that the detection rate is reasonably high and the false negative rate that is, faces being detected even though there is no face present, is reasonably low. What reasonable constitutes will depend on the actual context of the application. The [disclosure] disclosures of the Rowley and the Schneiderman [references is] documents are hereby incorporated [into this application] by reference in their entireties.

Page 12, Paragraph Beginning at Line 19

The basic approach for automatic eye detection is outlined in Fig. 4. As pre-processing step, any processing can be incorporated that will enhance facial features, as for instance, histogram normalisation, local contrast enhancement, or even red-enhancement according to Equation (1.1) for red-eye detection. In general, it is a good idea to normalise the input image, both in size and in lightness at this stage. The actual eye detection stage

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can be performed according to one of the many approaches that can be found in the literature. For instance, Benn et al propose a very interesting approach for the detection of eye centers based on a gradient decomposed Hough transform. Although Hough transforms might not appear the best choice due to rather large requirements on memory and processing speed, they show that this need can be greatly reduced by using the so-called gradient-decomposed Hough transform. A slightly different approach is taken by Kothari et al, "Detection of Eye Locations in Unconstrained Visual Images, Proc. Int. Conf. on Image Processing,; ICIP96; pp. 519-522; Lausanne; 1996, the disclosure of which is hereby incorporated by reference in its entirety, who analyse the flow field characteristics generated by the dark iris in respect to the light sclera. Another approach was proposed by Yuille et al, "Feature Extraction for Faces using Deformable Templates", International Journal of Computer Vision, 8:2, pp. 99-111, 1992, the disclosure of which is hereby incorporated by reference in its entirety. They suggested to use deformable templates for eye modes which are then drawn to the exact location by optimising the fit over some combination of energy fields. This is a very interesting approach that will give a lot of information about the detected eyes, however, there is a danger of the optimisation procedure being caught in local minima.

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Page 22, after Paragraph Beginning at Line 8

It will be appreciated by those skilled in the art that the present invention can be embodied in other specific forms whithout departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are therefore considered in all respects to be illustrated and not restricted. The scope of the invention is indicated by the appended claims rather than the foregoing description and all changes that come within the meaning and range and equivalence thereof are intended to be embraced therein.

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1. (Amended) Method for automatically correcting [colour] color defective areas in an image, said defective [colour] color areas being recorded with a [colour] color spectrum deviating from the actual [colour] color spectrum of said areas without [colour] color defects, [in particular automatic red eye correction, wherein] comprising the steps of:

a) identifying basic areas in the image [are identified] on the basis of features which are common for [these] recorded defective areas, [e.g. skin detection to identify skin related areas, face detection on the basis of a face pictogram or the like and/or an eye detection, and so on,] said basic areas supporting an increased likelihood of including defective areas[, in particular red eye defects];

b) reducing [the] a processing [is reduced] to the basic areas to identify at least one of borderlines [and/or] and centers of the defective areas[, in particular red eye defects];

c) identifying [it is identified] whether the [localised] basic [area or] areas[,] deemed to be defective[, is/are] are defective [or not, in particular whether a detected eye has a red eye defect or not]; and

d) creating [if a localised area, e.g. an eye, has been identified to be defective,] a correction mask [is created] to correct [the] a visual appearance of the defective area if a basic area has been identified to be defective.

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2. (Amended) Method according to claim 1, [characterized in that, alternatively to the feature 1 a),] wherein a [specialised] specialized portrait mode can be activated in the case of defective red eye detection.

3. (Amended) Method according to claim 1, wherein if[,] after one of the steps 1 a) [to], 1 b), and 1 c)[,] the processing of an image has not resulted in the identification of an area to be processed further, the processing of an image is stopped and another image can be processed.

4. (Amended) Method according to claim 1, wherein: after a center of a basic area[, e.g. an eye,] has been identified, an expected defect is [emphasised] emphasized in its intensity [(I, I_{red}),] to [more easily] detect whether the basic area is defective, [wherein] and in the case of a detected [colour] color defect[, in particular a defective red eye], the following [Equation is particularly useful] equation is used:

$$I_{red} = R - \min(G,B), \qquad [(Eq.\ 1.1),]$$

where R refers to a red [colour] color channel, G refers to a green [colour] color channel, and B refers to a blue [colour] color channel.

5. (Amended) Method according to claims 1, wherein the [basic area or] basic areas are treated by an edge detection processing to achieve borderlines of the basic areas.

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6. (Amended) Method according to claim 1, wherein in a case that a red eye defect is to be corrected and [the] a position and a size of [the] an iris have been estimated, [the] a maximum of the red eye defect is determined to be [the] an actual position of the iris of an eye.

7. (Amended) Method according to claim 6, wherein [neighbouring] neighboring pixels are [analysed] analyzed with respect to at least one of the actual position [or] and center of the iris considering several curves of [the] an HSV [colour] color space, which curves [were] are achieved by [analysing] analyzing a variety of real-world photographs with red eye defects to acquire fuzzy membership functions of three [colour] color channels to be taken into account, and determining intersections between at least three [colour] color channel positions of each of the [neighbouring] neighboring pixels and said fuzzy membership functions, [e.g. on the basis of the following Equation: r = hsv/(max(h,s,v,)) (Eq. 1.2),] and deciding on the basis of the intersection values that a particular [neighbouring] neighboring pixel is defective if its intersection values exceed a predetermined threshold, wherein a correction mask is created, if these steps are repeated for all relevant pixels.

8. (Amended) Method according to claim 7, wherein a first arrangement around [the] at least one of an equal position or center of the iris forms a first layer of first

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neighbouring pixels, and if the first layer of first [neighbouring] neighboring pixels is at least partially identified as belonging to the red-eye defective pixels, other second neighbouring pixels with respect to the first neighbouring pixels are [analysed] analyzed along a same line as the first neighbouring, pixels to be identified as red-eye defective pixels [or not], and if further red-eye defective pixels have been identified, considering further other neighbouring pixels, [and so on,] wherein the correction mask is caused to grow.

9. (Amended) Method according to claim 8, wherein the analysis of[,] and extension to[, neighbouring] neighboring pixels is terminated if at least one of no further other [neighbouring] neighboring pixels have been identified as red-eye defective [and/or] and if the borderlines of the defective red eye have been at least one of reached [or] and exceeded.

10. (Amended) Method according to claim 8, wherein [the] pixel data representing the correction mask area directed to at least one smoothing operation.

11. (Amended) Method according to claim 8, wherein the correction mask[, preferably a grey-scale correction mask,] is applied to the matching area of [the] an

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uncorrected image to remove the [colour] color defect[, and in particular the red-eye defect].

12. (Amended) Method according to claim 11, wherein the removal of the [colour] color defect[, and in particular the red-eye defect,] is [practised] practiced by [means of] the following [Equation] equation:

$I_{red\ new} = R\text{-}m(R\text{-}min(G,B))$, [(Eq. 1.3),]

where m is an element of the correction mask corresponding to a particular pixel of the uncorrected image.

13. (Amended) Method according to claim 11, wherein, if a particular pixel of the uncorrected image has a considerably large difference between the green channel and the blue channel, the larger channel is adjusted in accordance with [Equation (1.3).] the following equation:

$I_{red\ new} = R\text{-}m(R\text{-}min(G,B))$,

where m is an element of the correction mask corresponding to a particular pixel of the uncorrected image.

14. (Amended) [Image] An image processing device for processing image data, [including] comprising:

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[a)] an image data input section[,];

[b)] an image data processing section[,];

[c)] an image data recording section for recording processed image data, [d)] wherein the image data processing section implements a method [according to claim 1] for automatically correcting color defective areas in an image, said defective color areas being recorded with a color spectrum deviating from the actual color spectrum of said areas without color defects, including the steps of:

a) identifying basic areas in the image on the basis of features which are common for recorded defective areas, said basic areas supporting an increased likelihood of including defective areas;

b) reducing the processing to the basic areas to identify at least one of borderlines and centers of the defective areas;

c) identifying whether the basic areas deemed to be defective are defective; and

d) creating a correction mask to correct a visual appearance of the defective area if a basic area has been identified to be defective.